Joints and Fastenings in Steel-Glass Facades

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Introduction

Today lightness and transparency are properties that both architects and clients try to obtain. This has rapidly increased the use of glass in facades. By using steel as a load-bearing structure, it is possible to keep the transparency restricting structures slim.

In this master's thesis was gathered together information on research, design and codes about joints and fastenings in steel-glass facades. In addition to literature, focused interviews have been used as the source material of this master's thesis.

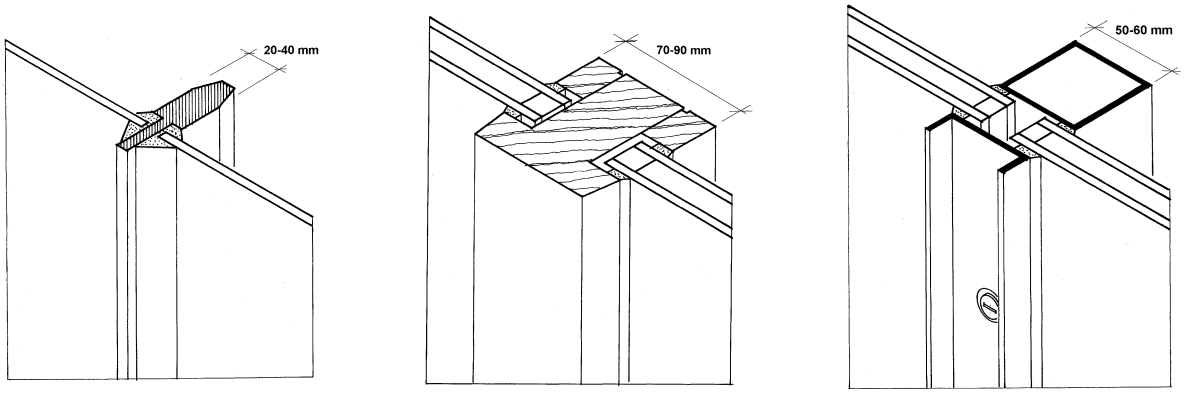
Glass

The use of glass in facades causes many problems due to the material properties of glass. Glass differs from other building materials in aspect of being an extremely brittle material and breaking without a forewarning. There are two typical effects of the behaviour of glass as a building material. First, the strength depends on the duration of the load application and on the environmental condition that can be e.g. dry, humid or wet. Second, the probability of failure is the greater the larger the stressed surface area and the more uniformly the stresses are distributed. In most cases failure does not originate only from points of maximum tensile stresses. This material property of brittleness has to be taken into account when designing large glass facades.

Joints and Connections

The connection types of steel-glass facades are putty glazing (old) (fig. 1), glass holder list (fig. 1), pressed fastening (fig. 1), structural silicone glazing (SSG) (fig. 2) and point supported glass panes (fig. 3). The new invention, point support, is used very little in Finland, although it nowadays can be applied in Finnish climatic conditions. Point supports are mainly constructed of stainless steel, sometimes also used corrosion

protected steel is used. The main requirements of supports are functionality with glass and very small tolerances. The requirement of small tolerances concern also the load-bearing structures. Point supports are affected by high stresses in drilling area, restraint loads caused by temperature and in insulation glass panes possibly even additional stresses caused by many-sheet-glazing. Difficulties of Finnish companies in producing point supports is a small ratio of potential market and developing costs.



1. 2. 3.

Figure 1. Sketch of linear supports of glass pane; 1. putty glazing, 2. glass holder list and 3. pressed fastening

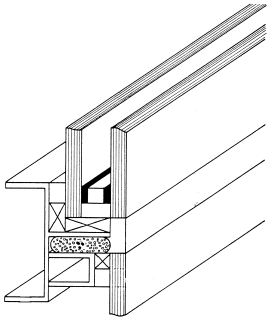


Figure 2 Sketch of joint of structural silicone glazing (SSG)

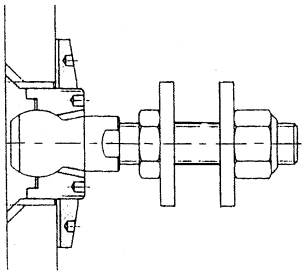


Figure 3 Photo and sketch of point support

Figure 4 Point supported glass facade (in Pikku-Huopalahti, Helsinki)

Conclusions

The main aspect in designing steel and glass joints is to consider the special material properties and behaviour of glass. Glass cannot have local plastic deformations and when glass is in direct contact with steel, small inequalities of steel can cause a crack in glass or break it. Therefore, a softer material always has to be used between steel and glass.

Development of transparent facades has been and is still fast and regulations are done much slower than the development would require. In Finland, this causes uncertainty of safety in designing and constructing of steel-glass facades. Therefore research information should be gathered together and regulations should be made. The regulations should consist overall behaviour of facades including load-bearing structures, joints and glass panes. The task is not easy because structural solutions of glazed facades are often so unique that applying some regulations might lead to bad situation in the end.

The fire resistance requirements of joints and fasteners are same as for the whole load-bearing structure. Fire protection of glass covered structures is essential in big open spaces. Today standard temperature-time curve is used, which leads to uneconomical solutions because of the fast rise in temperature. New SRMK E1 allows simulation of fire, but there are no rules by authorities for using fire simulation programmes. Also, the simulation programmes are only applicable to research use because the programmes give false answers if they are not used correctly.

The safety of individual parts of the steel-glass facades; load-bearing structures, profile parts, cladding parts and fastening parts are today rather well known. In further research overall safety of steel-glass facade should be clarified. Also the influence of different installation ways on the safety of the glass panes should be investigated.